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Department of Geology, University of Florida, Gainesville, Florida.

Quart. Jour. Florida Acad. Sci. 27(4) 1964 (1965)

TYPE LOCALITY OF *PLATYLEPAS WILSONI* ROSS

ARNOLD ROSS

IN a letter dated October 25, 1963, Druid Wilson has called my attention to the incorrect citation of the type locality of *Platylepas wilsoni* Ross (1963), U. S. Geological Survey Cenozoic locality 22805. The holotype was collected on the southwest side of Rim Ditch Canal, not the northeast side as stated. Furthermore, the type locality is approximately 175 yards northwest of the Florida East Coast Railroad bridge, not 500 yards northeast. The photograph of the type locality (op. cit., fig. 1) was taken approximately 500 yards from the bridge.

LITERATURE CITED

ROSS, ARNOLD. 1963. A new Pleistocene *Platylepas* from Florida. Quart. Jour. Florida Acad. Sci., vol. 26, no. 2, pp. 150-158, figs. 1-3.

Department of Geology, University of Florida, Gainesville, Florida.

Quart. Jour. Florida Acad. Sci. 27(4) 1964 (1965): 278

GLUCOSE NUTRITION AND LONGEVITY IN OYSTERS

LARRY GILLESPIE, R. M. INGLE, AND WALTER K. HAVENS

THE processes of growth and "fattening" are of fundamental importance to the oyster biologist and farmer. One of the objectives in oyster nutrition is to identify the various nutrients and feeds which can be utilized by this mollusk. The natural foods for the oyster are micro-organisms and perhaps detritus; however, the possibility that this shellfish is able to assimilate soluble substances such as carbohydrates should be considered.

The objectives of this study were to investigate the utilization of glucose in the nutrition of the oyster. Also, observations were made on the effect of glucose as a stimulator to pumping and on the length of life of the oyster in artificial sea water.

REVIEW OF LITERATURE

Yonge (1928) found that oysters were able to utilize glucose under abnormal conditions by indirect absorption by phagocytes. Loosanoff and Davis (1963) reviewed work done on the rearing of bivalve mollusks and summarized the effects of different foods on their growth. They developed a system of feeding oysters diatoms and other algae. Also, they have made studies indicating that bivalve larvae can utilize dried algae. Coe (1948) indicates that carbohydrates are digested in the intestinal tract and the food is particulate in form. Guillard and Wangersky (1958) found that extra-cellular carbohydrates are produced by many flagellates. Rhamosides and ascorbic acids have been isolated from sea water by Wangersky (1952). Dexter Haven (personal communication) has succeeded in conditioning oysters by using suspensions of sterilized cornstarch as a supplement in flowing sea water.

Collier and co-workers (1953) made extensive studies on soluble and naturally occurring carbohydrates and how they affect oysters. They found that natural occurring carbohydrates will increase the pumping rate of oysters at levels as low as 2.25 mg per liter. Glutamate, glycogen, methionine, and inositol will cause the cirri of oysters to beat more rapidly. Collier (1959) also reported data which indicate that oysters can utilize dissolved carbohydrates for energy. Through a series of tests in which he compared the caloric intake of the oyster against caloric output of energy, he

found that the output of energy was greater than the caloric intake. The output was measured by oxygen consumption; the intake was measured by the caloric value of the algae used for food.

EXPERIMENTAL PROCEDURE

Two experiments, one with oysters and one without oysters, constituted the study. The first experiment was designed to compare the longevity of oysters on starvation diet against the length of life of those receiving only glucose. The second experiment was designed to compare the concentration of glucose in the tanks with the oysters, from the first experiment, as against the concentration of glucose in tanks under similar conditions but without oysters.

EXPERIMENT NUMBER 1

Two epoxy-covered plywood tank systems that contained 310 liters of water each when maintained at the experimental level were used. The water was circulated in the tanks, passed through filters, and aerated by means of baffles. The filters each contained one pound of glass wool and five pounds of activated animal charcoal, and the water was filtered four hours per day. The purpose of the filters was to remove some of the foreign particles, metabolites, bacteria and other substances that might be produced in this system. Artificial sea water (Lyman and Fleming formula) adjusted to a range of 17.5 to 20 o/oo was used. The mixture was formulated and adjusted throughout the experiment with deionized water. NaHCO_3 was used to buffer the first batch to a pH of 7.9; in all other batches, Tris buffer was used to maintain a pH of 7.9 to 8.1. The water was changed approximately every four weeks.

Twenty-five scrubbed three-inch local oysters, *Crassostrea virginica* (Gmelin), were added to each tank. The control tank (No. 1), did not receive any glucose, and the experimental tank (No. 2) was fed as needed at a rate of 1.5 to 3.1 grams per day. An attempt was made to keep the concentration of the glucose in the tank between 5 and 15 mg per liter of water.

The total carbohydrate content was checked periodically using the anthrone method as described by Lewis and Rakestraw (1955). The mortalities, temperature and salinities were recorded daily, and the pumping of the oyster as indicated by gaping was checked

three times daily. It is recognized that gaping shells do not always prove that oysters are pumping. However, the correlation between the two events is generally fair and in a very gross way can be used as an index of pumping. It might also be argued that closed shells definitely preclude pumping; thus, pumping would be restricted to open valved individuals.

EXPERIMENT NUMBER 2

The same type of tank system, filter, and carbohydrate test as explained in Experiment 1 were used, but no oysters were introduced. For identification the tanks were labeled No. 3 and No. 4. Tank 3 was not filtered and Tank 4 was filtered four hours daily. The water pH and salinity were also maintained at the same level as in the previous experiment, and an attempt was made to maintain a maximum concentration of 15 mg per liter of water in each tank. The study was carried on for 24 days but no tests were made on the week ends.

RESULTS AND DISCUSSION

A comparison of the concentration of carbohydrates for both experiments is given in Table 1.

The steps of activities relating to glucose addition, filtration and related procedure are given here in order of their routine sequence.

1. Samples taken for the anthrone test.
2. Filtration.
3. Samples taken for the anthrone test.
4. Glucose added.
5. Samples taken occasionally for the anthrone test.

The total glucose in the tanks was established by adding the results of steps 3 and 4. The total glucose removed was determined by subtracting the results from step 3 from the total glucose found the previous day. In a similar manner the glucose removed by the filter was calculated by subtracting the results of step 3 from step 1. Also, the glucose removed by factors other than filter was determined as the difference between the total glucose removed and the glucose removed by the filter. All calculations are based on average daily values. Step 5 served only as a check.

TABLE 1
Average daily glucose concentration in tanks*

Amount of glucose	Tank 1	Tank 2	Tank 3	Tank 4
Concentration (mg/l)	.84	13.00	11.19	11.06
Grams added to maintain concentration	—	2.43	.86	2.11
Total grams in tank	.26	4.03	3.47	3.43
Total grams removed from tank	.01	2.55	1.11	2.35
Grams removed by filter	—	.29	—	.70
Grams removed by factors other than filter	—	2.26	—	1.64
Per cent of total glucose removed from tank	—	63.22	31.82	67.10
Per cent of glucose removed by filter	—	11.20	—	30.62
Percent of glucose removed by factors other than filter	—	88.80	—	69.38

*Total carbohydrate is recorded as glucose.

Tank 1: 85 days on test; with oysters; no glucose added; filtered 4 hours daily.

Tank 2: 69 days on test; with oysters; glucose added; filtered 4 hours daily.

Tank 3: 16 days on test; without oysters; glucose added; unfiltered.

Tank 4: 16 days on test; without oysters; glucose added; filtered 4 hours daily.

The anthrone test was taken periodically and the number of days recorded in this table were selected from the days that the test was run. An occasional test showed a slight increase in glucose concentration after filtration. These tests were disregarded; however, they would not have changed the results significantly.

Tank 1, which did not receive any glucose, had an average daily concentration of 0.84 mg/liter. Tank 2 had a maximum daily average of 13.00 mg/liter, which was equivalent to 4.03 gm of glucose in the system. An average of 2.26 gm of glucose was removed from the tank daily, in the sense that the glucose could no longer be detected as carbohydrate. Of the amount removed 11.20 per cent was removed by the filter and 88.80 per cent by other factors.

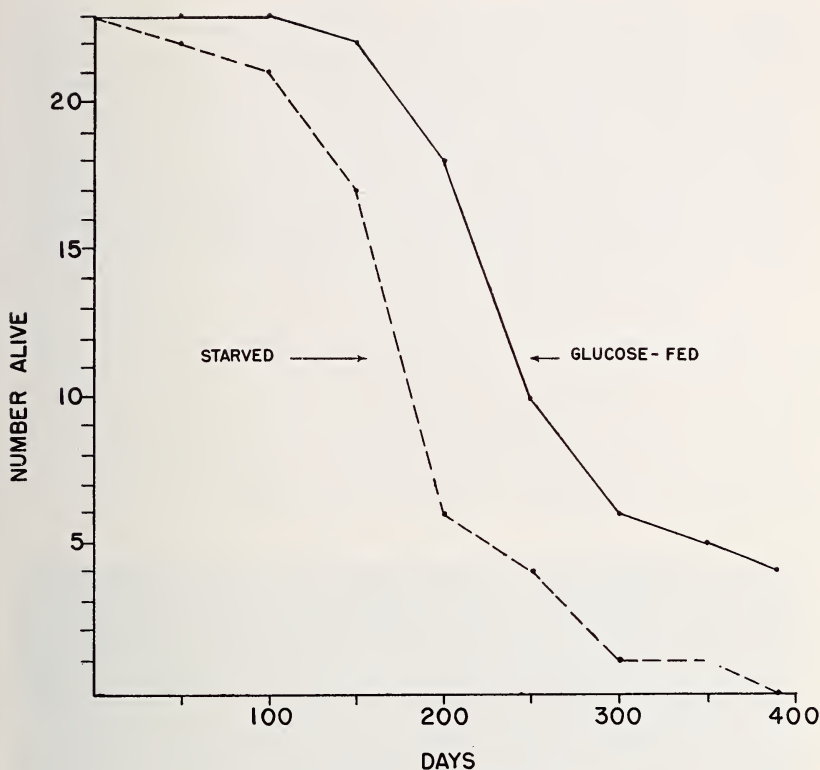


Fig. 1. Longevity of starved and glucose-fed oysters.

In the experiment without oysters, the non-filtered tank (No. 3) had a daily maximum concentration of 11.19 mg/liter which is equivalent to 3.47 gm in the tank. Of this, 31.82 per cent or 1.11 gm was removed daily. In the filtered tank (No. 4), the average daily maximum level was 11.06 mg /liter or 3.4 gm in the tank. Of the glucose removed, 69.38 per cent was removed by factors other than the filter. In comparing Tank 3 with Tank 4, it became apparent that filtration accounts for over 30 per cent of the glucose removed.

In comparing Tank 2 with Tank 4, 0.32 gm more glucose was needed daily to maintain the concentration in the tank with oysters. Furthermore, in the tanks with the oysters, 88.80 per cent of the glucose removed was removed by factors other than the filter; in the tank without oysters 69.38 per cent was similarly re-

moved. This would indicate that about 19.5 per cent of the glucose removed was used by the oysters. This loss of glucose could be accounted for either by direct assimilation or by an intermediate step of oysters feeding on micro-organisms which in turn had utilized the carbohydrate.

A comparison of the longevity of the oysters in Tanks 1 and 2 for one year is given in Fig. 1. At the end of 12 days, two oysters were sacrificed from each tank for a glycogen test and they were not recorded in this data.

The number of deaths for tanks No. 1 and 2, respectively, were as follows: 50 days—1, 0; 100 days—2, 0; 150 days—6, 1; 200 days—17, 5; 250 days—19, 13; 300 days—22, 17; 350 days—22, 18. At the end of 390 days all oysters had died in Tank 1 and 19 in Tank 2. On the basis of the mortality at the end of one year, it was found that oysters being fed glucose lived on an average of 68.2 days longer than the oysters not being fed.

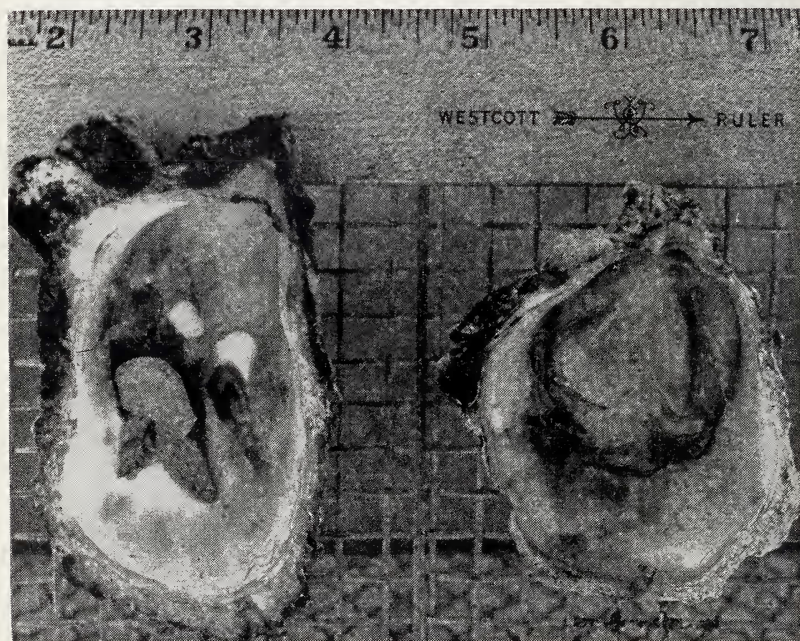


Fig. 2. Photograph of oysters at end of experiment. *Left*: Last surviving starved oyster after 390 days in artificial sea water. *Right*: One of four typical oysters surviving after 390 days in artificial sea water plus glucose.

During the 390th day of the experiment, the last oyster which had died from Tank 1 and the four oysters from Tank 2 were opened and examined. Figs. 2-3 compare the condition of the last oyster from Tank 1 with a typical individual from Tank 2. Extreme emaciation with almost complete degeneration of the mantle was noted in the starved oyster. Lack of "fatness" and a much smaller degree of emaciation were observed in the oysters from Tank 2. In the authors' opinion, the conditions noted occurred before death and were not due to post-mortem degeneration of tissue.



Fig. 3. Interpretative outline drawing of oyster meats derived from photograph in figure 2. *Left:* Meat of oyster starved 390 days. *Right:* Meat of oyster glucose-fed for 390 days.

It is recognized that glucose by itself is not a complete diet and would not be expected to sustain the oyster completely. It is of interest to note that the oyster when not subject to predation, disease or exorbitantly rigorous ecological conditions is very hardy and even when starved it is capable of living over a year.

The tenacity for life shown by the starved animals emphasizes anew the importance of infections, large carnivores, and extremes of hydrographic conditions in the mortalities of oysters. A lack of importance is suggested for temporary periods of nutritional inadequacies. This lack of importance has been suggested in earlier work. Mackin (personal communication) advises that in connection with other studies, he kept oysters alive in filtered water, from which presumably all organism and detritus were removed, for periods of many months. In a separate discussion of mortality, Mackin (1961) postulates a scant possibility for natural starvation.

The oyster tanks were housed in a concrete shed with screened doors and windows on all sides. They were always in the shade

and out of direct weather but otherwise subjected to ambient atmospheric variations. The daily temperatures listed as biweekly averages are given in Fig. 4. Since there was little or no variation in the temperature between tanks, the data are given as averages of the two tanks. Tanks 3 and 4 were housed in the same shed, and the water temperatures were essentially the same as given in this chart for the period covered. The temperature varied from a low of 1.8°C on one occasion to a high of 28.0°C on four days. For fifteen consecutive weeks, the daily average water temperature was above 25°C . Of this, four weeks averaged above 27°C and nine weeks averaged above 26°C . Seventeen oysters died through the 19th to 25th weeks inclusive. During this seven week period, the average water temperature was 26°C or above. It could not be said with certainty that the high temperature accelerated the death rate, but it appears that this was the case. It is of interest to note that of the seventeen oysters that died during this warm period only four were from the tank being fed glucose.

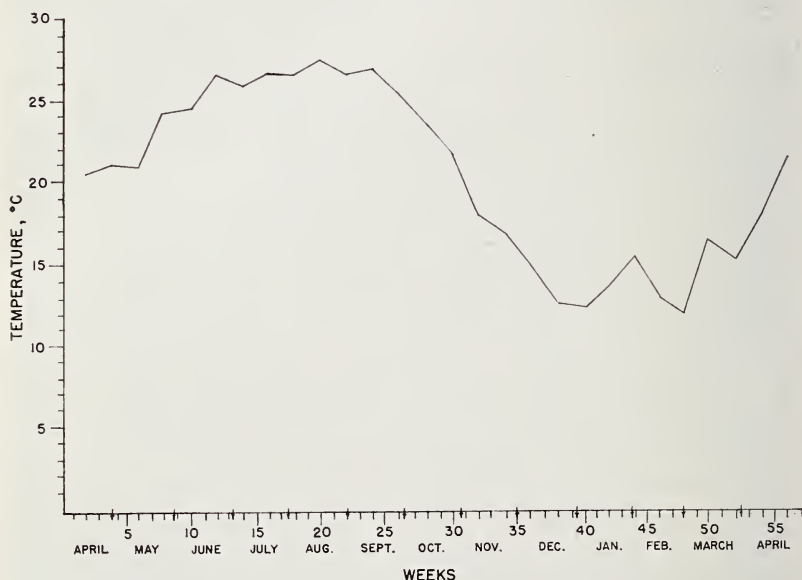


Fig. 4. Biweekly average daily ambient temperatures.